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Terrestrial invertebrates in south-west Australian forests: the role of relict species and habitats in reserve design

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Abstract

Invertebrates are an integral and functional component of any ecosystem, including the south-west Australian forests. However they are often overlooked in biological studies. This is partly due to the incompleteness of taxonomic knowledge, as much of the invertebrate fauna is unnamed. Also, while a great deal of distributional data exists for invertebrates, it is generally not readily accessible, often associated only with individually stored museum specimens and/or scattered taxonomic descriptions in the literature. It is proposed here that a pragmatic approach to invertebrate conservation via reservation is to consider the known distribution of selected relict species (because of their sensitivity to disturbance) and their microhabitat requirements, and (a) deduce whether such species/habitats are adequately included in the current reserve system and (b) if not, then predict where in the overall domain they are likely to occur, with a view to ensuring their persistence. A short-cut method is to note the location of Gondwanan-type sites and argue for their preservation on the grounds that they will contain relict species assemblages. This approach assumes that widespread and/or ecologically tolerant species are more likely to have other options in the face of artificial disturbance.

Introduction

In the catch-phrases of an attention-seeking society, while "big may be beautiful" in reference to the role of invertebrates in biological processes and ecosystems, perhaps the apt phrase is "small and significant". Wilson (1987) convincingly argued for the dependance on invertebrates of higher life forms, and the support base provided by invertebrates in any ecosystem. The decline of some local insectivorous birds is commonly remarked upon. Hence it is ironic that although nature conservation is now a well established and even "popular" discipline with a practical and ethical base, little attention has been given to invertebrates (in their own right) until relatively recently. In Australia, compared to vertebrates and flora, invertebrates have fared poorly with respect to conservation. Amongst the general publications devoted to invertebrates, those of New (1984, 1995) are notable, and there are also studies dealing with particular groups, for example a recent review on arachnid conservation by Yen (1995).

Under the blanket concept and ethos of conservation must be considered the practical manifestation: reservation of places for invertebrates. How then, if at all, does the practicality of reservation for terrestrial invertebrates differ from that for flora or vertebrates? Or can they be assumed to be safe-guarded along with whatever methods are applied in reserve establishment and management for the more obvious biota such as vascular plants and vertebrates? It must be noted that in spite of their significance, invertebrates are frequently overlooked in broad sweep ecological studies and biological surveys because of their small size and often cryptozoic behaviour.

Nevertheless there are statutory requirements in Western Australia concerning the conservation of all fauna and dissemination of knowledge related to that fauna. The Strategic Plan 1995 of the Department of Conservation and Land Management (Anon 1995a) states under the major functions of CALM firstly, *"Conservation of Nature. To conserve the indigenous biota and ecological processes in natural habitats throughout the State"* and fourthly *"Knowledge. To ensure that .... functions* [i.e. concerning conservation] *are underpinned by up-to-date and reliable science-based knowledge."* These objectives surely partner in intent the Western Australian Museum Act which charges the Western Australian Museum *"to make and preserve ... collections representative ..... of the natural history of the State"* (Anon 1969). Furthermore the Science and Information Division of CALM has been developed to meet several inclusive needs; *"to document the biota, ecological processes & biological resources of the state"*, *"to conserve threatened species & ecological communities by ameliorating inimical processes"*, and *"to ensure that land & biological resources are used sustainably"* (Anon 1995a). This would suggest that all is well for our natural heritage (including the significant smaller " taxa") and that a beneficent authority is taking good care of our fauna and is about to inform us (if not already having done so) of what we have and will continue to have, within our south-west forests.

Invertebrates - a special case

However I argue here that if conservation reserves within the region under discussion within the 800mm rainfall isohyet (for instance forested landscapes) are to adequately cater for conservation of invertebrates then

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the special characteristics and needs of this fauna must be considered. These needs stem primarily from one or more of the following characteristics and phenomena;

- the sheer diversity and taxonomic range of invertebrates. Some idea of this diversity can be gauged from spiders: this arachnid order is represented by at least 50 families in Western Australia of which all but a few occur in the south-west forest and some of which occur only in the region (Main 1985 and unpublished);
- the range of foraging methods from vegetative to predatory and parasitic;
- the range of life histories and individual longevity ranging from a few days to over 30 years;
- the differing dispersal methods, particularly of juveniles, and mobility of various life history stages;
- the range of site fidelity from sedentary to partially territorial or transitory;
- the interaction of life cycle patterns with other biota;
- the association with particular physiographic configurations; and
- the antiquity of many forms/taxa.

All the above phenomena/characteristics are a consequence of the historical ecology of the particular taxon especially of the "ancient" groups which has been determined by the environmental history of the landscape including geological and climatic changes and changes in the vegetation which relate to earlier continental configurations and their positions.

Because of their small size and often specialised behaviour, particularly of relict forms, many invertebrates (in contrast to most vertebrates) are confined to topographically or geographically restricted areas and specialised microhabitats which may not be readily perceived by broader scale surveys. Such microhabitats are vulnerable to artificial disturbances imposed by agriculture, forestry and other rural and urban disruptions to the landscape, for instance roads and other human constructions.

Current knowledge-base of invertebrates

We might digress now and look at our current knowledge-base relating to invertebrates of the south-west forest of Western Australia by asking the following question. Is there a taxonomic database (either as lists of taxa contained in the Western Australian Museum and/or other collections or in the published literature), arranged or accessible according to the region in the present context, habitat data, and whether present in the current reserve system?

Firstly there is a great deal of information on local distributions of invertebrate taxa for the south-west forest region in the taxonomic literature. Nearly 3000 papers dealing with all aspects of invertebrates of Western Australia are listed in the excellent bibliography compiled over 15 years ago by Majer & Chia (1980). In spite of this, the taxonomic and distributional data needed now are not readily or rapidly accessible and are largely uncoordinated, except for particular groups which specialists have in their personal research files. For example a recent paper by Abbott (1994) discusses the distribution of earthworms in the south-west and shows a spatter of dots on a map within the 400mm rainfall zone. The data were derived from museum collections and published records but are not readily accessible. Similarly, many systematists including myself (for spiders) have unpublished species lists from particular parks or localities.

Secondly, some associated habitat data accompany stored specimens and taxonomic literature records, but except for a very few groups are either uncoordinated or unpublished.

Thirdly, the greater proportion of the invertebrate fauna (and not just insects) is unnamed. Hence biological and distribution data associated with stored specimens, as well as being not readily accessible, cannot be manipulated in the same way as vertebrate data. Statements such as, *"All states and the Commonwealth have a database of threatened and rare species observations .... "*, from the Deferred Forests Assessment document (DFA, Anon 1995b, p 5) are largely irrelevant for invertebrates as such databases refer almost exclusively to vertebrates. However, Abbott (1995) has produced a valuable resource in his selective list of insects recorded in the literature from the jarrah and karri forests of southwestern Western Australia; he noted *"nearly 1800 insect and closely allied species of ... Hexapoda"* from south-west forests but estimated that the total number could be 15 000 to 20 000.

Suggested guide-lines for reservations

In spite of the absence of comprehensive, usable databases of invertebrates, a case study could be made of selected taxa to determine guidelines for reserve selection. This could be based on what knowledge we do have regarding relictual taxa including Gondwanan elements (*e.g.* spiders and other arachnids, selected insects, amphipods, earthworms, nemerteans, Onycophora *etc*), which are confined to certain habitats and in some cases geographic areas. Bearing in mind the foregoing points regarding the restricted nature and vulnerability of habitats of relic taxa, the converse is assumed for later evolved/adapted groups and/or more widespread taxa, when such taxa are likely to be more resilient to artificial disturbance and fragmentation of habitats.

Definition of relict taxa and habitats

Some definition of relict taxa and their associated habitats needs to be made. Generally such taxa are representative of a fauna from a more humid, less markedly-seasonal climate associated with a mesophytic forest with closed canopy and as such they are relicts of a pre-fire-prone environment. With progressively dryer and more seasonal climatic conditions, the most favourable habitats have become increasingly fragmented until now such fauna are restricted to specialised *microhabitats* which simulate on a small scale an earlier more widespread habitat. Relict taxa include extremely ancient representatives of Gondwanan

elements and with lineages reaching back to pre-Cretaceous times (120 - 140 million years ago) *e.g.* the trapdoor spider *Moggridgea* (see Main 1991) and velvet worms (Onycophora) or to the early Tertiary Eocene/ Oligocene period 40 - 50 mya (Main 1987). Striking austral zoogeographic affinities are found within many spider families, including the Archaeidae and Pararchaeidae (Forster & Platnick 1984; Platnick 1991; Main 1995), Orsolobidae (Forster & Platnick 1985; Griswold & Platnick 1987), which can best be interpreted as relict distributions from a contracted early Tertiary environment. Presence of the Micropholcommatidae and Archaeidae in south-western Western Australia has been explained in this manner (Main 1974, 1995). The distribution of certain terrestrial insect groups such as thrips of the family Aeolothripidae (Mound 1972) can also be interpreted to be of this era.

Many groups of invertebrates from both periods have taxonomic affinites with south-easten Australia, Tasmania, New Zealand and/or other southern continents. It is outside the scope of this paper to document the many examples which, from perusal of the taxonomic literature indicate Gondwanan affinities. Some relationships are listed by Main & Main (1991) and Hopper *et al.* (1996).

The associated habitats of relict species are permanently moist and shaded, with such conditions provided by high rainfall. However other formative physiographic conditions include topography, proximity to coast and directional orientation. Main & Main (1991), Hopper *et al.* (1996), and A R Main (1996) have summarised the major characteristics of persistent Gondwanan habitats in south-west Western Australia. In addition B Y Main (1996) has demonstrated the occurrence of relictual Gondwanan microhabitats on the plateau region of southern Western Australia.

Location of relict habitat sites

The major high rainfall areas on geologically old terrain include the Walpole/Nornalup topographically high region, the high etched region west of Manjimup and Pemberton and farther north, and isolated regions near Collie, Dwellingup and Jarrahdale. Areas which are wet by virtue of old erosional phenomena combined with orientation include the northern valleys of the Darling Scarp such as near Mundaring and Kalamunda, and farther south in the sinuous configurations of rivers, such as the Deep River, which have further significance by having a continuity with the fauna of the Walpole/ Nornalup area. Noteworthy also are some Pleistocene sites (including cave complexes) and areas of the Perth Coastal Plain, as at Jandakot, where relict fauna has encroached from "older" areas. Farther south the limestones of the Mammoth Cave area and Boranup with high rainfall and wet karri forest contain certain relicts.

Typical minor or "special" areas are sites associated with granite outcrops which benefit from run-off (sometimes created simply by dew and light mist), summits of emergent monadnocks and south facing slopes, swampy headwaters of river systems, perched "swamps" and so on. Even within the general forest, regardless of minor topography, there are further secretive "micro-sites" such as; the litter "stacks" or "rings" around the butts of karri and accumulated debris in the buttresses of tingle (Wallis 1992); the persistent spongy (if not recently burnt) bark of red tingle; long unburnt rotten logs; stag-heads of old trees and debris in tree forks (particularly sheoaks) and trunk crevices.

As well as high rainfall, the prevalence of fog whether induced by topography or coastal proximity, promotes persistence of wet "microhabitats". Examples are remnants of the old plateau (including Mt Cooke and Mt Saddleback in the jarrah forest), Mt Lindesay near Denmark, granite outcrops and south coast peninsulas such as Torndirrup and West Cape Howe. Again, within such sites subtle microhabitats can be further specified.

From the foregoing it is apparent that when considering reservations of sites to include invertebrates (whether at the species or community level), different, smaller scale criteria need to be used than is the case for vertebrates.

The DFA document (Anon 1995b) emphasises the importance of using physical environmental data in the absence of adequate community data "to ensure that representativeness is met". This approach is paramount in the selection of reserves encompassing invertebrate preservation.

Bench-mark information

Contained within the stored collections and literature records is extractable bench-mark information of distributions of taxa prior to continuing disturbance. Notable are the reports of the Michaelsen & Hartmeyer Expedition to south-western Western Australia in 1905 (Michaelsen & Hartmeyer 1907-30). Nearly 90 sites were sampled, of which about 25 were in the forest-zone extending from Jarrahdale to Nornalup and Albany. Within the forest and neighbouring areas, accessibility was both facilitated and constrained by forestry activities ranging from logging and milling to timber transport and loading of ships at Bunbury, Hamelin Bay and Torbay. Ironically it is the contemporary timber industry that is provoking most research and fortuitous gathering of collections and knowledge of much of the invertebrate fauna of the forest.

Collection methods in 1905 were both haphazard and less refined than some of the current techniques and the collectors did not have our hindsight of environmental and taxonomic knowledge to be able to predict where relict (Gondwanan) species would be likely to occur. Nevertheless it is notable that this expedition was staged on the premise that the south-west peninsula of Australia would be the biogeographic complement of the southern areas of South America and South Africa which regions the German team had already sampled. Later taxonomic studies confirm this premise.

The relevance of the bench-mark collections, in combination with later records, to the selection of reserves must not be ignored.

Summary

I suggest that by selecting named relict taxa, noting their microhabitat requirements, predicting where such

microhabitats are likely to occur in the forest, and combining the above with recorded locality data for such relict taxa, then it should be possible to deduce whether all known relict taxa and their full geographic ranges are represented within the present reserve system, and conversely whether all "relict" sites and concomitant, potential unnamed species are catered for in the present reserve system.

Obviously we don't have the luxury of time to ferret out even the recorded information of species, habitats and distributions to impose these data as a template on the geographic area. However, this needs to be done, taxon by taxon by various specialists in a co-ordinated manner.

The practical short-cut suggested here places priority on physiographic features likely to contain any of the microhabitat categories described above and as delineated by Main & Main (1991), A R Main (1996), B Y Main (1996) and Hopper *et al.* (1996), and indeed where our major biotrove lies. I suggest that this approach is an ideal guide for selection of reserves containing microhabitats appropriate to relict, geographically restricted and specialised invertebrates. The more widespread and/or ecologically tolerant species have a wider range of natural options and are also better able to cope with artificially disrupted habitats.

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